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PROGRESS REPORT OF A STUDY OF THE BLACK HILLS BEETLE IN SOUTHEASTERN WYOMING AND CENTRAL COLORADO SUMMER OF 1937

By

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And

Donald De Leon, Assoc. Entomologist.

Forest Insect Laboratory,
Fort Collins, Colorado,
May 16, 1938.

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[Mtn. Pine Beetle]

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INTRODUCTION

This is the third report on a study of biology of the Black Hills beetle, Dendroctonus ponderosae Hopk., in lodgepole and limber pine at Elk Mountain in southeastern Wyoming. As the data in this report deal chiefly with the results of the past season's study, the two earlier reports -- the first by Whiteside (1936) and the second by Whiteside and Beal (1937) -- should be consulted for complete information. In addition to the data on the Elk Mountain study, the results of a similar study made last summer in the ponderosa pine stands of central Colorado are included to facilitate comparison of the habits of the beetle in the two localities. This latter work was carried out at Wah Keeney Park, near Evergreen, Colorado, at an elevation of slightly more than 7,500 feet. Evergreen, Colorado is about 30 miles west of Denver.

THE AREAS

As the nature of the Elk Mountain area and the type of infestation present there have been given in the two previous reports, only a brief discussion of that area and the new area at Wah Keeney Park will be given here for the purpose of ready comparison.

The Elk Mountain area is in a rugged country, the mountain rising to a height of 11,162 feet. It is covered with a fair stand of lodgepole pine, limber pine, Engelmann spruce, and Douglas fir. The infestation which developed one or two years earlier than the Colorado infestation is also much more severe, over 200,000 trees being infested on an area of 10,240 acres, and is found principally in the limber pine stands, 79 percent of the infested trees being that species and only 21 percent lodgepole pine.

The infestation at Wah Keeney Park is a part of the Denver Mountain Parks infestation which reached epidemic proportions in 1935 (Beal and Hester, 1937). A survey in the fall of 1937 showed 7,400 newly infested trees over an area of 77,525 acres. Most of this area, which is rather rolling and about 7,500 feet in elevation, is covered by an almost pure ponderosa pine stand. At the higher elevations lodgepole pine and limber pine occur, occasionally in heavy stands, but the activity of the beetles is almost completely confined to ponderosa pine.

In 1936 studies were also conducted in the Mullison Creek area on the Medicine Bow National Forest, Wyoming, near Elk Mountain, but no work was done there in 1937 as control work in the fall of 1936 cleaned up the infestation.

PROCEDURE

At Elk Mountain between July 13 and 15, 1937, 25 additional trees were caged on each of two sides with two square feet of 18-mesh copper screen in the same manner as in 1936. Twenty of these trees had been attacked by the Black Hills beetle in 1936. The remaining five trees had also been attacked in 1936 but each already had one cage that had been put on late in 1936. This was done in order to prevent the entrance of parasites and predators. The tree species caged to date and the number at each elevation are as follows:

Trees Caged on Both Sides on the Same Date

Elevation	Lodgepole Pine			Limber Pine		
	1935*	1936*	1937*	1935*	1936*	1937*
8,000 ft.	3	3	-	2	3	5
9,000	3	2	5	2	2	3
10,000	2	2	4	4	3	3

*Year of caging; the trees were attacked the previous year.

Trees Attacked in 1936 and Caged on One Side Late in 1936; on Opposite Side in July 1937

Elevation	Lodgepole Pine	Limber Pine
9,000 ft.	-	2
10,000	1	2

At Wah Keeney Park 20 trees were caged July 18-20 in the same manner and with the same sized cages as those at Elk Mountain.

COLLECTIONS

At Elk Mountain 25 collections were made during the season from each of the cages. They were emptied usually at two-day intervals except at the beginning and end of the season when the collections were more widely spaced. In all cases every specimen in the collection jars was saved and placed in a separate vial according to collection date, tree number, and cage. The specimens were then later separated in the laboratory with the aid of a microscope. Although this method did not increase the accuracy of the Black Hills beetle counts it did increase appreciably the number of different species of arthropods found to be associated with the primary insect, since a more careful and critical separation of the various species was possible.

A brief discussion is given at the end of this report on the associated arthropods collected from these cages. A complete report on these species will be given when determinations of all the less common species have been secured.

The same method of making collections was employed at Wah Keeney Park where 23 collections were made at two to three day intervals.

BROOD COUNTS

No brood counts were made in 1937 at Elk Mountain. At Wah Keeney Park counts of the number of Black Hills beetle attacks, inches of gallery, amount of brood, and number of associated insects were made on 70 ponderosa pines. A total of 451.5 square feet of bark was sampled. The sampling was done in square foot units on the north and south side of each tree at 10-ft. intervals beginning at a height of 5 feet. Each of the samples was first divided into a half square foot and all the data for each of these halves recorded separately. The object of keeping the data on each half separate was to determine whether half square foot samples were sufficiently large to permit a representative sampling of the brood and if it was not whether a square foot would be sufficient. Subjection of these data to a statistical analysis showed in the first place that a sufficient number of counts were not made at any of the heights to give a representative sampling of the population. Not over 62 and in most cases fewer than this number of samples were secured at 5, 15, 25, and 35 feet, etc. respectively. The standard deviation of these samples was equal to or greater than their mean. If data were desired with a probable accuracy of 95 percent it would be necessary to secure over 440 samples; for a probable accuracy of 68 percent 110 samples would be necessary.

The statistical analysis of the data also showed that one square foot samples did not increase the accuracy of the sampling.

As personnel is not available to make any brood counts the coming season, no plans have been made for future studies on this phase of the problem.

Table VIII tabulates the brood counts, and Table IX the cage emergence of the Black Hills beetle at Wah Keeney Park. It should be noted that the counts show practically no difference between the amount of brood on the north and south sides of the tree at 5 feet but the cage emergences show almost double the emergence from the north side as from the south side at practically the same height. No explanation is advanced at this time to account for this discrepancy.

NEW ADULT EMERGENCE

In 1935 the emergence per square foot from caged limber pine was much greater than the emergence from the caged lodgepole pine. In 1936 this difference was much smaller but again in 1937 there was much greater emergence from the limber pine than from the lodgepole pine. This is shown in the table below which groups the data for the three elevations, i.e., 8,000, 9,000, and 10,000 feet:

Year of Emergence	Emergence Per Square Foot, All Three Elevations: Lodgepole Pine	Sq. Ft. of Cages	Limber Pine	Sq. Ft. of Cages
1935	18.2	32	164.5	28
1936	51.9	40	89.1	32
1937	19.7	40	88.1	60

Table I summarizes the 1937 emergence data based on the collections mentioned above. For comparative purposes it is arranged in the same manner as Table I of the report of 1936 and Table III of last year's report. A study of these three tables shows that there is so great a variation in both the number and percent of beetles emerging from the north and south side of each tree species over the three year period at the three elevations that no well founded conclusions can be made except possibly that not a sufficient number of samples have been secured. At Wah Keeney Park, where there were 80 square feet of cages on 20 ponderosa pines at a single elevation (7,500 feet), the variation in emergence between trees and between north and south sides was also found to be so great that the data on average emergence and the number of beetles emerging from the two sides did not appear significant when subjected to statistical analysis. In the light of these Wah Keeney records it is probable that only by greatly increasing the number of samples will significant data be secured.

Consequently, it would seem that unless this study can be greatly enlarged to include a vastly greater number of samples, a possibility which at this time is non-existent, further caging studies to determine the average emergence and thus the trend of an infestation will not be worth while.

Table II, a and b for limber pine, Table III, a and b for lodgepole pine, and Table Xa for ponderosa pine, show the number of beetles secured at each collection and the percentages of the total emergence by side for each species respectively. Tables IV, V, and Xb give the totals of the sides combined. Charts I to IV inclusive show much of this information graphically. They are discussed in detail under the heading "Duration of Emergence."

SECOND-YEAR EMERGENCE

As in 1936 some Black Hills beetles were found to have a two-year life cycle. There can be but little doubt that this is a regular occurrence with this species in certain localities at least. Of the total emergence for the two years (from trees attacked in 1935) from both limber and lodgepole pine 192 beetles emerged during 1937 or 9.4% of the total number of the brood emerging from trees with second-year emergence. This is practically the same as the second-year emergence for 1936 which was 9%. These results are tabulated in Table VI. If the table is broken down according to species, however, the similarity disappears as can be seen by the following summary:

	Percent of Second-Year Emergence of Total Emergence	
	1936 Emergence From 1934 Attacked Trees	1937 Emergence From 1935 Attacked Trees
Lodgepole Pine	4.4	20.
Limber Pine	9.2	4.5

As with first-year emergence per square foot there appears to be no relation between the amount of second-year emergence and tree species or elevation and side of tree from which the emergence occurred, but that second-year emergence is appreciable there can scarcely be any doubt.

The frequency of this type of emergence by elevation and tree species for the past two years is summarized below:

Tree Species and Elevation	Frequency of Second-Year Emergence Year of Emergence 1936	1937
Limber Pine		
8,000 ft.	0 out of 2 trees	2 out of 3 trees
9,000	2 out of 2 trees	1 out of 2 trees
10,000	3 out of 3 trees	3 out of 3 trees
Lodgepole Pine		
8,000 ft.	0 out of 3 trees	0 out of 3 trees
9,000	0 out of 3 trees	1 out of 1 tree
10,000	2 out of 2 trees	2 out of 2 trees

Observations in 1936 indicated that the two-year emergence was confined to elevations of about 9,000 feet and over, but the collections in 1937 show that some second-year emergence occurred from limber pine as low as 8,000 feet. Two of the three caged limber pines at 8,000 feet showed this two-year emergence of beetles. These beetles, however, composed so small a part (0.87%) of the total number emerging that unless further study reveals a much higher percent of second-year emergence to be the rule there will be no need to modify the spotting methods used at present at this elevation.

No records have been secured on the presence or absence of second-year emergence in ponderosa pine.

THIRD-YEAR EMERGENCE

Black Hills beetles were collected in 1937 from four limber pines attacked in 1934 and caged in 1935. This emergence is tabulated below:

Third-Year Emergence from Limber Pine -- 1937

Tree Number	Side	Date Collected	Elevation in Feet 9,000	10,000
9	S	June 26	1	-
10	N	Aug. 22	-	1
	S	July 15	1	-
12	S	June 26	-	1
13	S	Aug. 22	-	1

Those beetles collected June 26, the date of the first collection, may possibly have emerged late the previous year and been overlooked when the collection jars were replaced in the spring. The other beetles, it seems, must have taken three years to complete their development. More information is needed on this apparently new point in the beetles' life history.

DURATION OF EMERGENCE

First-Year Emergence

Emergence during the past season at Elk Mountain was as would be expected, beetles emerging from trees at the lower elevations earlier than from those at the higher elevations. In 1936 the first emergence was from trees at 10,000 feet elevation but this early emergence was believed to have been parent adults. Charts II, III, and IV show graphically the 1937 emergence.

Emergence for the past three years by tree species and elevation is tabulated below:

Period of Emergence Showing Date of First and Last Emergence

Tree Species	Year	Elevation in Feet 8,000	9,000	10,000
Limber Pine	1935	July 24° - Sept.22	July 24° - Oct. 6	July 26° - Oct. 12
	1936	July 15 - Sept.11	July 15 - Sept.11	July 10* - Sept.11
	1937	July 15 - Sept. 8	July 28 - Oct. 9	July 28 - Sept. 22
Lodgepole Pine	1935	Aug. 7 - Sept. 9	Aug. 7 - Sept.15	Aug. 15 - Oct. 6
	1936	July 16 - Sept. 4	July 25 - Sept.11	July 10** - Sept.11
	1937	-----	July 30 - Sept.22	June 26 - Oct. 9
Ponderosa Pine	1937	July 22 - Oct. 7	-----	-----

° Estimated as first collection date on Aug. 7 at 8,000 and 9,000 feet and on Aug. 15 at 10,000 feet.

* Only a few beetles emerged on this date and July 16; main emergence began July 25.

** 3.5 percent of the total emergence occurred on this date, no further emergence occurred until the principal emergence began July 25.

The peaks of the main emergence from limber pine at 8,000 feet occurred at practically the same time in 1936 and 1937; at 9,000 and 10,000 feet they were a week later in 1937 than in 1936. In 1935, peak emergence for both lodgepole and limber pine at 9,000 feet practically coincided with peak emergence at 8,000 feet but at 10,000 feet it was slightly more than two weeks later. An interesting point is brought out on Chart V which shows the emergence of the Black Hills beetle from ponderosa pine at Wah Keeney Park in relation to the Elk Mountain emergence. At Elk Mountain at 10,000 feet, the peak of emergence from limber pine is on Aug. 22, while at Wah Keeney Park, 2,500 feet lower and about 150 miles farther south, the peak of emergence is three days later, Aug. 25. The similarity of the emergence curves of the beetle in these two localities is shown clearly in Chart IV where the curves for the emergence from the south side practically coincide.

Unfortunately no weather records were kept for these two localities during the emergence period so it is not known whether unseasonably cool weather at Wah Keeney Park could account for the late emergence at that locality.

Table VII shows the principal percentages of emergence in 1937 and the number of days elapsing from the first emergence to these percentages, broken down according to the north and south sides of the trees. In every case the principal percentages were reached in fewer days on the south side of the tree than on the north side. In 1936 some of the emergences from the north sides reached the principal percentages in fewer days than those of the south side. In both years the last emergence from both sides was roughly 60 days after the first emergence. The table below shows, for 1936 and 1937, the number of days elapsing from the first emergence to peak emergence, both sides averaged together:

Number of Days Elapsing from First Emergence to Peak Emergence

Tree Species and Elevation	Year 1936	1937
Limber Pine		
8,000 feet	17	14
9,000	24	19
10,000	35	26
Lodgepole Pine		
8,000 feet	16	--
9,000	20	17
10,000	42	30
Ponderosa Pine		
8,000 feet	--	33

An unexpected condition is brought out by the 1937 collections from six trees which were attacked about July 1, 1936, six weeks earlier than the occurrence of the main attack. Four of these trees were limber pines, two each at 10,000 and 9,000 feet respectively. The other two trees were lodgepole pines, one being at each of these two elevations. One would have expected that since the attack on these trees occurred approximately six weeks earlier than the main attack that the emergence of the new adults the following year would have been correspondingly earlier. Such was not the case, peak emergence from the earlier attacked trees occurring at approximately the same time as the peak emergence from the trees attacked by beetles of the main flight.

This information on the distribution of the peaks and duration of emergence is of value in determining how early fall surveys can be started, and if fall control work is to be done, which is highly advisable both from the standpoint of satisfactory weather conditions and the preservation of parasites and predators, how soon it too may be begun and at what elevations.

Second-Year Emergence

As would not be expected second year emergence was found to extend over practically the same period of time and time of the year as the first year emergence, with the peaks of the second year emergence occurring slightly later than the first year emergence. Not enough data have yet been secured, however, on this phase of the study to enable one to draw anything but tentative conclusions.

PARENT ADULT EMERGENCE

No records were secured on the occurrence or amount of parent adult emergence in 1937 for any of the three tree species studied.

EFFECT OF ELEVATION ON TOTAL EMERGENCE

A study of Table I shows that greatest emergence per square foot for limber pine occurred at 8,000 feet and the smallest emergence at 10,000 feet. For lodgepole pine the situation is reversed. These data are the opposite of the results of last year's collections and only in partial agreement with the 1935 collections. Thus it appears from the data at hand that elevation has no appreciable effect on total emergence.

EFFECT OF SIDE OF TREE ON EMERGENCE

Although there seems to be no correlation between elevation and emergence per square foot there may possibly be a relationship between side of tree from which emergence occurred and emergence per square foot. Both in 1936 and 1937 the emergence from limber pine was greatest on the north side at 8,000 feet and greatest on the south side at 9,000 and 10,000 feet. In 1935, however, this condition was exactly the reverse. With lodgepole pine in 1935 and 1937 more emergence occurred from the north side than from the south side at 9,000 and 10,000 feet with the situation being reversed for 1936. Greater numbers of beetles emerged from the north side of

ponderosa pine at Wah Keeney Park than from the south side, which is in agreement with the records for limber pine at the same elevation -- 8,000 feet. The seeming tendency towards greater broods from the south side of limber pine and fewer beetles from the south side of lodgepole pine at 9,000 feet and 10,000 feet can not at present be explained. The conflicting data for these three years are probably the result of inadequate sampling.

TREND OF EPIDEMIC

Unfortunately lack of personnel made it impossible to survey in 1937 the sample strips laid out on Elk Mountain in 1935 in order to determine the trend of the epidemic. General observations, however, indicate that the infestation is still on the increase. In the entire area it has apparently increased from about 65,000 infested trees in 1935 to an estimated total of over 200,000 in 1937.

INFESTATION IN LODGEPOLE PINE

As the Mullison Creek infestation in lodgepole pine on the Medicine Bow National Forest was cleaned up by control work last year no further information is available on the ability of the Black Hills beetle to continue to increase in pure lodgepole pine stands. The broods in limber pine in the Elk Mountain area in 1935 were about eight times as heavy as that in lodgepole pine; in 1936 it was about one and a half times as heavy; and in 1937 it was about four times as heavy as indicated by the cage records.

ASSOCIATED INSECTS

A separate report will be prepared on the insects and other arthropods found associated with the Black Hills beetle in the rearing cages on limber pine, lodgepole pine, and ponderosa pine. The following account merely touches on a few of the more interesting points.

In 1935 and again in 1936 fewer than 50 different species and 1800 different specimens were recorded for both lodgepole pine and limber pine together. Although all of the species collected in 1937 have not yet been determined a rough estimate indicates that over 140 different species are associated with the Black Hills beetle in one way or another. The emergence last year from the three host trees of Black Hills beetle and associated insects is summarized below:

Number of Specimens Emerging in 1937

	Host Tree							
	Ponderosa Pine	Sq. ft. Bark Surface		Lodgepole Pine	Sq. ft. Bark Surface		Limber Pine	Sq. ft. Bark Surface
Black Hills beetle	2240	80		788	40		5288	60
Associated insects	5733	80		3235	40		4758	60

It is not known whether this increase in the number of associated insects will have any effect on the trend of the Elk Mountain infestation.

In the following table the ten most common insects other than the Black Hills beetle are shown for each tree species:

Tree Species and Number of Specimens of the Ten Most Common Associated Insects for Each Tree Species

Insect	Ponderosa	Lodgepole	Limber
Corticeus spp.	849	114	583
Aulonium longum	847		
Cecidomyiid larvae, sp. a	621		
Cecidomyiid larvae, sp. b	541		
Othnius larvae	501		
Hylurgops subcostulatus	316		
Collembolids	255		
Orthotomicus ornatus	204		
Corticaria elongata	142		
Plegaderus sp.	104		
Formica sp. ?		532	497
Rhizophagus dimidiatus		530	436
Pityophthorus spp.		467	
Epurea sp.		405	161
Myrmica sp.		188	113
Rhyphid-like larvae			535 ±
Nitudulid larvae		102	480
Neopachygasterinae larvae			262
Medetera aldrichii			187
Staphylinid larvae, sp. a			143
Coeloides dendroctoni		64	
Collembolids		57	
Acarina, sp. a		49	
Total	4380	2508	3397

It will be noted from the above tabulations that the most common associated insects for the most part do not consist of the same species in each of the three trees and that they compose over 75 percent of the total specimens present.

SUMMARY

A study of the biology and habits of the Black Hills beetle in lodgepole and limber pine was started in 1935 and continued through 1937 at Elk Mountain in southeastern Wyoming. In addition similar studies were carried out for the beetle in ponderosa pine in 1937 at Wah Keeney Park, near Evergreen, Colorado.

At Elk Mountain in 1935 and 1936, cages were placed on 31 trees. In 1937, cages were erected on 20 more trees, 11 of which were limber pine, the remainder lodgepole pine. At Wah Keeney Park, 40 cages were placed on 20 ponderosa pines. All cages covered two square feet of bark surface.

Emergence from limber pine in 1935 was 9 times as great as from lodgepole pine, in 1936 it was a little less than 2 times as great although brood counts showed 3 times as much brood in limber pine as in lodgepole pine; in 1937 the emergence from limber pine was about 4 times that from lodgepole pine, and almost three times that from ponderosa pine.

A total of 5,288 beetles emerged from 60 square feet of limber pine bark giving an average of 88.1 per square foot; the greatest number of beetles emerging from one cage was 503 from a south side cage at 8,000 feet. The smallest number was 1 at 9,000 feet from a south side cage.

A total of 788 beetles emerged from 40 square feet of lodgepole pine bark giving an average of 19.7 per square foot. The most beetles emerging from a cage was 115 at 10,000 feet from a south side cage; the smallest number was 1 at 9,000 feet from a north side cage.

A total of 2,240 beetles emerged from 80 square feet of ponderosa pine bark giving an average of 28 per square foot. The most beetles emerging from a cage was 182 from a north side cage; the smallest number was 0 from two south side cages.

The percent-of-emergence curve of the beetle from ponderosa pine at Wah Keeney Park practically coincided with the percent-of-emergence curve of the beetle from limber pine at Elk Mountain 2,500 feet higher and about 150 miles farther north than Wah Keeney Park.

Peak emergence from limber pine in 1937 was only partly similar to that of 1936.

No records were secured concerning parent adult emergence in 1937 for any tree species.

Second-year emergence was found to be about the same (9%) as last year when emergence from both tree species is averaged together. When broken down into tree species this apparent similarity was not confirmed.

A small amount of third-year emergence occurred in 1937 but in such small numbers that it may not be a regular occurrence.

Elevation does not seem to affect the amount of brood per square foot.

As in 1935 and 1936 emergence from limber pine is heaviest from the south side of the tree when all elevations are averaged together but slightly greater emergence occurred from the north side of the trees at 8,000 feet than from the south side.

The north side of lodgepole pine in 1937 produced more brood at both elevations than did the south side. The same tendency was found in 1935 and 1936.

Ponderosa pine in 1937 likewise produced more brood on the north side than on the south side.

Parasites, predators, and associated arthropods were found to be more numerous in 1937 than in 1935 or 1936. In 1935 and 1936 fewer than 50 different species and 1800 specimens were recorded for both lodgepole and limber pine together. In 1937 for the same tree species over 140 different species were secured totalling 7993 specimens. It is not yet known whether this increase in the number of associated insects will have any effect on the trend of the infestation. At Wah Keeney Park about the same number of different species were secured from ponderosa pine as from lodgepole and limber pine together but the species and relative numbers were not similar.

Brood counts were made in 1937 only on infested ponderosa pine. The counts were made on a square-foot basis, a total of 451.5 square feet of bark surface from 70 trees being examined. These data when subjected to a statistical analysis showed that an insufficient number of samples had been secured, and therefore no conclusions were drawn from the data secured.

RECOMMENDATIONS

It is recommended that the greatest amount of time the coming field season be devoted to study of the following Black Hills beetle problems:

1) The comparative brood development of the Black Hills beetle in the three main hosts in this region and the host preference of the beetles emerging from them.

2) Second-year emergence at lower elevations.

3) Third-year emergence.

4) Parent beetle emergence.

5) Temperature requirements for emergence.

6) Relation of parasites and predators to Black Hills beetle population and the biology of those species that appear to be the most important as controlling agencies.

*****

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TABLE I -- Total Emergence of the Black Hills Beetle from Caged Limber Pine - 1937 New Adults

	8,000 Feet Elevation		9,000 Feet Elevation		10,000 Feet Elevation		
	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage	
	#39 - 503	#39 - 407	#36** - 4	#36 - 1	#32* - 10	#32 - 240	
	40 - 174	40 - 183	37* - 18	37 - 4	33* - 208	33 - 403	
	41 - 358	41 - 437	44 - 68	44 - 174	50 - 11	50 - 6	
	42 - 137	42 - 103	48 - 139	48 - 124	51 - 20	51 - 112	
	56 - 346	56 - 188	49 - 240	49 - 498	55 - 84	55 - 88	
Total emergence	1518	1318	469	801	333	849	
Square feet of bark caged	10	10	10	10	10	10	
Emergence per square foot	151.8	131.8	46.9	80.1	33.3	84.9	
Total emergence	2836		1270		1182		
Square feet of bark caged	20		20		20		
Emergence per square foot	141.8		63.5		59.1		
Total emergence							5288
Square feet of bark caged							60
Emergence per square foot							88.13

Total Emergence of the Black Hills Beetle from Caged Lodgepole Pine - 1937 New Adults

		9,000 Feet Elevation		10,000 Feet Elevation		
		North Cage	South Cage	North Cage	South Cage	
		#38 - 27	#38 - 14	#34* - 95	#34 - 52	
		43 - 16	43 - 16	35 - 20	35 - 12	
		45 - 44	45 - 6	52 - 87	52 - 73	
		46 - 1	46 - 6	53 - 54	53 - 41	
		47 - 12	47 - 38	54 - 59	54 - 115	
Total emergence		100	80	315	293	
Square feet of bark caged		10	10	10	10	
Emergence per square foot		10	8	31.5	29.3	
Total emergence		180		608		
Square feet of bark caged		20		20		
Emergence per square foot		9		30.4		
Total emergence						788
Square feet of bark caged						40
Emergence per square foot						19.7

** South side caged in 1936; North side in 1937.
* North side caged in 1936; South side in 1937.

TABLE II-a -- The Emergence of the Black Hills Beetle from Limber Pine -- North Cages, 1937

Collection Date	8,000 Feet Elevation					9,000 Feet Elevation					10,000 Feet Elevation				
	# of Trees	Total D.p.	% of Total	Total to Date	% of Total	# of Trees	Total D.p.	% of Total	Total to Date	% of Total	# of Trees	Total D.p.	% of Total	Total to Date	% of Total
6/26/37	5	0	0	0	0	5	0	0	0	0	5	0	0	0	0
7/15/37	5	2	.1	2	.1	5	0	0	0	0	5	0	0	0	0
7/16/37	5	0	0	2	.1	5	0	0	0	0	5	0	0	0	0
7/28/37	5	406	26.7	408	26.9	5	2	.4	2	.4	5	0	0	0	0
7/30/37	5	217	14.3	625	41.2	5	3	.7	5	1.1	5	0	0	0	0
8/ 1/37	5	154	10.1	779	51.3	5	0	0	5	1.1	5	0	0	0	0
8/ 3/37	5	187	12.3	966	63.6	5	2	.4	7	1.5	5	2	.6	2	.6
8/ 5/37	5	170	11.2	1136	74.8	5	2	.4	9	1.9	5	0	0	2	.6
8/ 7/37	5	106	7.0	1242	81.8	5	2	.4	11	2.3	5	1	.3	3	.9
8/ 9/37	5	89	5.9	1331	87.7	5	2	.4	13	2.8	5	1	.3	4	1.2
8/11/37	5	62	4.1	1393	91.8	5	16	3.5	29	6.2	5	1	.3	5	1.5
8/13/37	5	52	3.4	1445	95.2	5	96	20.5	125	26.7	5	4	1.2	9	2.7
8/16/37	5	18	1.2	1463	96.4	5	240	51.2	365	77.8	5	6	1.8	15	4.5
8/18/37	5	3	.2	1466	96.6	5	18	3.8	383	81.7	5	2	.6	17	5.1
8/20/37	5	6	.4	1472	97.0	5	25	5.3	408	87.0	5	6	1.8	23	6.9
8/22/37	5	2	.1	1474	97.1	5	17	3.6	425	90.6	5	26	7.8	49	14.7
8/24/37	5	0	0	1474	97.1	5	18	3.8	443	94.5	5	19	5.7	68	20.4
8/26/37	5	27	1.8	1501	98.9	5	7	1.5	450	95.9	5	6	1.8	74	22.2
8/28/37	5	16	1.1	1517	99.9	5	8	1.7	458	97.7	5	54	16.2	128	38.4
8/30/37	5	0	0	1517	99.9	5	0	0	458	97.7	5	1	.3	129	38.7
9/ 3/37	5	0	0	1517	99.9	5	5	1.1	463	98.7	5	47	14.1	176	52.9
9/ 8/37	5	1	.1	1518	100.0	5	1	.2	464	98.9	5	51	15.3	227	68.2
9/15/37	5	0				5	4	.9	468	99.8	5	67	20.1	294	88.3
9/22/37	5	0				5	0	0	468	99.8	5	39	11.7	333	100.0
10/9/37	5	0				5	1	.2	469	100.0	5	0			
		1518					469					333			

TABLE II-b -- The Emergence of the Black Hills Beetle from Limber Pine -- South Cages, 1937

Collection Date	8,000 Feet Elevation					9,000 Feet Elevation					10,000 Feet Elevation				
	# of Trees	Total D.p.	% of Total	Total to Date	% of Total	# of Trees	Total D.p.	% of Total	Total to Date	% of Total	# of Trees	Total D.p.	% of Total	Total to Date	% of Total
6/26/37	5	0	0	0	0	5	0	0	0	0	5	0	0	0	0
7/15/37	5	0	0	0	0	5	0	0	0	0	5	0	0	0	0
7/16/37	5	0	0	0	0	5	0	0	0	0	5	0	0	0	0
7/28/37	5	265	20.1	265	20.1	5	9	1.1	9	1.1	5	3	.4	3	.4
7/30/37	5	175	13.3	440	33.4	5	0	0	9	1.1	5	0	0	3	.4
8/ 1/37	5	118	8.9	558	42.3	5	0	0	9	1.1	5	0	0	3	.4
8/ 3/37	5	144	10.9	702	53.3	5	6	.7	15	1.9	5	0	0	3	.4
8/ 5/37	5	259	19.7	961	72.9	5	18	2.2	33	4.1	5	0	0	3	.4
8/7/37	5	125	9.5	1086	82.4	5	44	5.6	77	9.6	5	0	0	3	.4
8/ 9/37	5	89	6.8	1175	89.2	5	47	5.9	124	15.5	5	1	.1	4	.5
8/11/37	5	66	5.0	1241	94.2	5	139	17.4	263	32.8	5	0	0	4	.5
8/13/37	5	41	3.1	1282	97.3	5	299	37.4	562	70.2	5	13	1.5	17	2.0
8/16/37	5	24	1.8	1306	99.1	5	159	19.9	721	90.0	5	66	7.8	83	9.8
8/18/37	5	2	0.2	1308	99.2	5	17	2.1	738	92.1	5	17	2.0	100	11.8
8/20/37	5	6	0.5	1314	99.7	5	17	2.1	755	94.3	5	54	6.4	154	18.1
8/22/37	5	0	0	1314	99.7	5	15	1.9	770	96.1	5	173	20.4	327	38.5
8/24/37	5	2	0.2	1316	99.8	5	16	2.0	786	98.1	5	108	12.7	435	51.2
8/26/37	5	1	0.07	1317	99.9	5	5	.6	791	98.8	5	121	14.3	556	65.5
8/28/37	5	1	0.07	1318	100.0	5	4	.5	795	99.3	5	96	11.3	652	76.8
8/30/37	5	0				5	0	0	795	99.3	5	1	.1	653	76.9
9/ 3/37	5	0				5	2	.2	797	99.5	5	74	8.7	727	85.6
9/ 8/37	5	0				5	2	.2	799	99.8	5	62	7.3	789	92.9
9/15/37	5	0				5	1	.1	800	99.9	5	50	5.9	839	98.8
9/22/37	5	0				5	1	.1	801	100.0	5	10	1.2	849	100.0
10/9/37	5	0				5	0				5	0			
		1318					801					849			

TABLE III-a -- The Emergence of the Black Hills Beetle from Lodgepole Pine -- North Cages, 1937

Collection Date	8,000 Feet Elevation	9,000 Feet Elevation				10,000 Feet Elevation				
		# of Trees	Total D.p.	% of Total	Total to Date	% of Total	# of Trees	Total D.p.	% of Total	Total to Date	% of Total
6/26/37		5	0	0	0	0	5	1	.3	1	.3
7/15/37		5	0	0	0	0	5	0	0	1	.3
7/16/37		5	0	0	0	0	5	0	0	1	.3
7/28/37		5	0	0	0	0	5	1	.3	2	.6
7/30/37		5	1	1.0	1	1.0	5	0	0	2	.6
8/ 1/37		5	0	0	1	1.0	5	0	0	2	.6
8/ 3/37		5	0	0	1	1.0	5	0	0	2	.6
8/ 5/37		5	0	0	1	1.0	5	0	0	2	.6
8/ 7/37		5	2	2.0	3	3.0	5	1	.3	3	1.0
8/ 9/37		5	6	6.0	9	9.0	5	2	.6	5	1.6
8/11/37		5	12	12.0	21	21.0	5	1	.3	6	1.9
8/13/37		5	16	16.0	37	37.0	5	6	1.9	12	3.8
8/16/37		5	19	19.0	56	56.0	5	10	3.2	22	7.0
8/18/37		5	11	11.0	67	67.0	5	10	3.2	32	10.2
8/20/37		5	6	6.0	73	73.0	5	8	2.5	40	12.7
8/22/37		5	7	7.0	80	80.0	5	26	8.3	66	21.0
8/24/37		5	7	7.0	87	87.0	5	67	21.3	133	42.2
8/26/37		5	2	2.0	89	89.0	5	80	25.4	213	67.6
8/28/37		5	2	2.0	91	91.0	5	38	12.1	251	79.7
8/30/37		5	1	1.0	92	92.0	5	5	1.6	256	81.3
9/ 3/37		5	3	3.0	95	95.0	5	28	8.9	284	90.2
9/ 8/37		5	1	1.0	96	96.0	5	15	4.7	299	94.9
9/15/37		5	4	4.0	100	100.0	5	11	3.5	310	98.4
9/22/37		5	0				5	4	1.3	314	99.7
10/9/37		5	0				5	1	.3	315	100.0
			100					315			

TABLE III-b -- The Emergence of the Black Hills Beetle from Lodgepole Pine -- South Cages, 1937

Collection Date	8,000 Feet Elevation	9,000 Feet Elevation					10,000 Feet Elevation				
		# of Trees	Total D.p.	% of Total	Total to Date	% of Total	# of Trees	Total D.p.	% of Total	Total to Date	% of Total
6/26/37		5	0	0	0	0	5	0	0	0	0
7/15/37		5	0	0	0	0	5	0	0	0	0
7/16/37		5	0	0	0	0	5	0	0	0	0
7/28/37		5	0	0	0	0	5	1	.3	1	.3
7/30/37		5	0	0	0	0	5	0	0	1	.3
8/ 1/37		5	0	0	0	0	5	0	0	1	.3
8/ 3/37		5	0	0	0	0	5	1	.3	2	.7
8/ 5/37		5	3	3.8	3	3.8	5	1	.3	3	1.0
8/ 7/37		5	1	1.2	4	5.0	5	0	0	3	1.0
8/ 9/37		5	6	7.5	10	12.5	5	1	.3	4	1.4
8/11/37		5	3	3.7	13	16.3	5	2	.7	6	2.0
8/13/37		5	17	21.3	30	37.5	5	8	2.7	14	4.8
8/16/37		5	15	18.8	45	56.3	5	37	12.6	51	17.4
8/18/37		5	2	2.5	47	58.8	5	12	4.1	63	21.5
8/20/37		5	5	6.3	52	65.0	5	19	6.5	82	28.0
8/22/37		5	7	8.8	59	73.8	5	61	20.8	143	48.8
8/24/37		5	5	6.3	64	80.0	5	24	8.2	167	57.0
8/26/37		5	10	12.5	74	92.5	5	36	12.3	203	69.3
8/28/37		5	0	0	74	92.5	5	23	7.8	226	77.1
8/30/37		5	1	1.2	75	93.8	5	1	.3	227	77.5
9/ 3/37		5	1	1.2	76	95.0	5	25	8.5	252	86.0
9/ 8/37		5	0	0	76	95.0	5	20	6.8	272	92.8
9/15/37		5	3	3.7	79	98.8	5	13	4.4	285	97.3
9/22/37		5	1	1.2	80	100.0	5	4	1.4	289	98.6
10/9/37		5	0				5	4	1.4	293	100.0
			80					293			

TABLE IV -- Combined Total of Black Hills Beetle Emergence from North and South Cages -- Limber Pine, 1937

Collection Date	8,000 Feet Elevation				9,000 Feet Elevation				10,000 Feet Elevation			
	No. Dp.	Percent Emerged	Total to Date	Percent of Total	No. Dp.	Percent Emerged	Total to Date	Percent of Total	No. Dp.	Percent Emerged	Total to Date	Percent of Total
6/26/37	0	0	0	0	0	0	0	0	0	0	0	0
7/15/37	2	.06	2	.06	0	0	0	0	0	0	0	0
7/16/37	0	0	2	.06	0	0	0	0	0	0	0	0
7/28/37	671	23.7	673	23.7	11	.9	11	.9	3	.3	3	.3
7/30/37	392	13.8	1065	37.6	3	.2	14	1.1	0	0	3	.3
8/ 1/37	272	9.6	1337	47.1	0	0	14	1.1	0	0	3	.3
8/ 3/37	331	11.7	1668	58.8	8	.6	22	1.7	2	.2	5	.4
8/ 5/37	429	15.1	2097	73.9	20	1.6	42	3.3	0	0	5	.4
8/ 7/37	231	8.1	2328	82.1	46	3.6	88	6.9	1	.1	6	.5
8/ 9/37	178	6.3	2506	88.4	49	3.9	137	10.8	2	.2	8	.7
8/11/37	128	4.5	2634	92.9	155	12.2	292	23.0	1	.1	9	.8
8/13/37	93	3.3	2727	96.2	395	31.1	687	54.1	17	1.4	26	2.2
8/16/37	42	1.5	2769	97.6	399	31.4	1086	85.5	72	6.1	98	8.3
8/18/37	5	.2	2774	97.8	35	2.8	1121	88.3	19	1.6	117	9.9
8/20/37	12	.4	2786	98.2	42	3.3	1163	91.6	60	5.1	177	15.0
8/22/37	2	.06	2788	98.3	32	2.5	1195	94.1	199	16.8	376	31.8
8/24/37	2	.06	2790	98.4	34	2.7	1229	96.8	127	10.7	503	42.6
8/26/37	28	1.0	2818	99.4	12	.9	1241	97.7	127	10.7	630	53.3
8/28/37	17	.6	2835	99.9	12	.9	1253	98.7	150	12.7	780	66.0
8/30/37	0	0	2835	99.9	0	0	1253	98.7	2	.2	782	66.2
9/ 3/37	0	0	2835	99.9	7	.6	1260	99.2	121	10.2	903	76.4
9/ 8/37	1	.02	2836	100.0	3	.2	1263	99.4	113	9.6	1016	86.0
9/15/37	0				5	.4	1268	99.8	117	9.9	1133	95.9
9/22/37	0				1	.1	1269	99.9	49	4.1	1182	100.0
10/9/37	0				1	.1	1270	100.0	0			
	2836				1270				1182			

TABLE V -- Combined Total of Black Hills Beetle Emergence from North and South Cages -- Lodgepole Pine, 1937

Collection Date	8,000 Feet Elevation	9,000 Feet Elevation				10,000 Feet Elevation			
		No. Dp.	Percent Emerged	Total to Date	Percent of Total	No. Dp.	Percent Emerged	Total to Date	Percent of Total
6/26/37		0	0	0	0	1	.2	1	.2
7/15/37		0	0	0	0	0	0	1	.2
7/16/37		0	0	0	0	0	0	1	.2
7/28/37		0	0	0	0	2	.3	3	.5
7/30/37		1	.5	1	.5	0	0	3	.5
8/ 1/37		0	0	1	.5	0	0	3	.5
8/ 3/37		0	0	1	.5	1	.2	4	.7
8/ 5/37		3	2.0	4	2.0	1	.2	5	.8
8/ 7/37		3	2.0	7	4.0	1	.2	6	1.0
8/ 9/37		12	6.7	19	10.6	3	.5	9	1.5
8/11/37		15	8.3	34	18.9	3	.5	12	2.0
8/13/37		33	18.3	67	37.2	14	2.3	26	4.3
8/16/37		34	18.9	101	56.1	47	7.7	73	12.0
8/18/37		13	7.2	114	63.3	22	3.6	95	15.6
8/20/37		11	6.1	125	69.4	27	4.4	122	20.1
8/22/37		14	7.8	139	77.2	87	14.3	209	34.4
8/24/37		12	6.7	151	83.9	91	15.0	300	49.3
8/26/37		12	6.7	163	90.6	116	19.1	416	68.4
8/28/37		2	1.1	165	91.7	61	10.0	477	78.5
8/30/37		2	1.1	167	92.8	6	1.0	483	79.4
9/ 3/37		4	2.2	171	95.0	53	8.7	536	88.2
9/ 8/37		1	.5	172	95.6	35	5.8	571	93.9
9/15/37		7	3.9	179	99.4	24	3.9	595	97.9
9/22/37		1	1.1	180	100.0	8	1.3	603	99.2
10/9/37		0				5	.8	608	100.0
		180				608			

TABLE VI

Black Hills Beetle Emergence of 1936 and 1937

from 1935 Attacked Trees

Elevation	Side of Tree	Tree Species	Emergence 1936	Emergence 1937	Total
8,000 ft.	N	Limber Pine	150	1	151
8,000	N	" "	246	3	249
8,000	S	" "	268	1	269
9,000 ft.	N	Limber Pine	146	1	147
9,000	N	Lodgepole Pine	47	73	120
9,000	S	" "	77	14	91
10,000 ft.	N	Limber Pine	83	47	130
10,000	N	" "	136	5	141
10,000	S	" "	400	1	401
10,000	S	" "	111	10	121
10,000	N	Lodgepole Pine	32	19	51
10,000	N	" "	50	4	54
10,000	S	" "	176	4	180
10,000	S	" "	108	9	117
Total emergence			2030	192	2222
Square feet of bark			28		
Beetles per square foot			72.5	6.9	79.4
Percent emergence			90.6	9.4	100.

TABLE VII -- The Dates and the Number of Days After the Start of the Black Hills Beetle Emergence on Which Important Percentages Occurred

Elevation	Tree Species Pine	First Emergence		50 Percent Emergence		75 Percent Emergence		90 Percent Emergence		Last Emergence	
		South	North	South	North	South	North	South	North	South	North
8,000 feet	Limber	7/28/37	7/15/37	8/ 3/37 6*	8/ 1/37 17	8/ 5/37 8	8/ 5/37 21	8/ 9/37 12	8/ 9/37 25	8/28/37 31	9/ 8/37 55
	Ponderosa**	7/22/37	7/22/37	8/22/37 31	8/22/37 31	8/25/37 34	8/25/37 34	8/30/37 39	8/30/37 39	9/17/37 57	10/7/37 77
9,000 feet	Limber	7/28/37	7/28/37	8/12/37 15	8/15/37 18	8/13/37 16	8/16/37 19	8/16/37 19	8/22/37 25	9/22/37 56	10/9/37 63
	Lodgepole	8/ 5/37	7/30/37	8/16/37 11	8/16/37 17	8/22/37 17	8/20/37 21	8/26/37 21	8/26/37 26	9/22/37 48	9/15/37 46
10,000 feet	Limber	7/28/37	8/ 3/37	8/24/37 27	9/ 3/37 31	8/28/37 31	9/ 8/37 36	9/ 8/37 42	9/15/37 43	9/22/37 56	9/22/37 57
	Lodgepole	7/28/37	6/26/37	8/22/37 25	8/25/37 60	8/28/37 31	8/28/37 63	9/ 8/37 42	9/ 3/37 69	10/9/37 73	10/9/37 105

* Number of days after the start of emergence.
** Wah Keeney Park, Colorado.

TABLE VIII

Black Hills Beetle Brood Counts in Ponderosa Pine

Wah Keeney Park, Colo., 1937.

Height of Sampling in Feet	Total Sq. Ft. Examined	Brood per Square Foot		
		North Side	South Side	Both Sides
5	121.0	33.1	33.6	33.4
15	120.0	44.7	32.2	38.6
25	98.0	39.9	30.2	35.3
35	60.5	31.9	26.2	29.2
45	19.0	32.7	12.4	23.1
55	8.0	44.6	19.0	35.0
65	4.0	22.0	5.0	13.5
75	1.0	10.0	----	10.

TABLE IX -- Total Emergence of the Black Hills Beetle from Caged Ponderosa Pine, Wah Keeney Park - 1937 new Adults

	8,000 Ft. Elevation		9,000 Feet Elevation	10,000 Feet Elevation
	North Cage	South Cage		
#1	7	9		
2	61	6		
3	39	14		
4	151	18		
5	182	61		
6	107	136		
7	125	60		
8	98	8		
9	111	115		
10	10	0		
11	70	4		
12	22	4		
13	101	7		
14	2	0		
15	34	2		
16	75	47		
17	1	42		
18	157	104		
19	107	75		
20	7	61		
Total emergence	1467	773		
Square feet of bark caged	40	40		
Emergence per square foot	36.68	19.33		
Total emergence				2240
Square feet of bark caged				80
Emergence per square foot				28

TABLE X-a -- The Emergence of the Black Hills Beetle from Ponderosa Pine, Wah Keeney Park, 1937

Collection Date	8,000 Ft. Elevation - North Cages					8,000 Ft. Elevation - South Cages				
	Number of Trees	Total D.p.	Percent of Total	Total to Date	Percent of Total	Number of Trees	Total D.p.	Percent of Total	Total to Date	Percent of Total
7/22/37	20	2	.1	2	.1	20	2	.2	2	.2
7/23/37	20	0	0	2	.1	20	0	0	2	.2
7/24/37	20	0	0	2	.1	20	0	0	2	.2
7/28/37	20	3	.2	5	.3	20	1	.1	3	.4
7/30/37	20	3	.2	8	.5	20	1	.1	4	.5
8/ 1/37	20	2	.1	10	.7	20	1	.1	5	.6
8/ 3/37	20	6	.4	16	1.1	20	1	.1	6	.8
8/ 6/37	20	6	.4	22	1.5	20	0	0	6	.8
8/ 9/37	20	23	1.6	45	3.1	20	5	.6	11	1.4
8/11/37	20	28	1.9	73	5.0	20	13	1.7	24	3.1
8/13/37	20	46	3.1	119	8.1	20	13	1.7	37	4.8
8/16/37	20	190	13.0	309	21.1	20	70	9.1	107	13.8
8/18/37	20	105	7.2	414	28.2	20	53	6.9	160	20.7
8/20/37	20	127	8.7	541	36.9	20	63	8.2	223	28.8
8/22/37	20	220	15.0	761	51.9	20	79	10.2	302	39.1
8/25/37	20	342	23.4	1103	75.2	20	199	25.8	501	64.8
8/27/37	20	159	10.8	1262	86.0	20	120	15.5	621	80.3
8/30/37	20	96	6.5	1358	92.6	20	61	7.9	682	88.2
9/ 3/37	20	84	5.8	1442	98.3	20	53	6.9	735	95.1
9/ 6/37	20	8	.5	1450	98.8	20	17	2.2	752	97.3
9/ 9/37	20	5	.3	1455	99.2	20	11	1.4	763	98.7
9/17/37	20	8	.5	1463	99.7	20	10	1.3	773	100.0
9/23/37	20	3	.2	1466	99.9	20	0			
10/7/37	20	1	.1	1467	100.0	20	0			
		1467					773			

TABLE X-b -- Combined Total Black Hills Beetle Emergence from North and South Cages, Ponderosa Pine, Wah Keeney Park, 1937

Collection Date	8,000 Feet Elevation				9,000 Feet Elevation	10,000 Feet Elevation
	Number D.p.	Percent Emerged	Total to Date	Percent of Total		
7/22/37	4	.2	4	.2		
7/23/37	0	0	4	.2		
7/24/37	0	0	4	.2		
7/28/37	4	.2	8	.4		
7/30/37	4	.2	12	.5		
8/ 1/37	3	.1	15	.7		
8/ 3/37	7	.3	22	1.0		
8/ 6/37	6	.3	28	1.3		
8/ 9/37	28	1.3	56	2.5		
8/11/37	41	1.8	97	4.3		
8/13/37	59	2.6	156	7.0		
8/16/37	260	11.6	416	18.6		
8/18/37	158	7.1	574	25.6		
8/20/37	190	8.5	764	34.1		
8/22/37	299	13.3	1063	47.5		
8/25/37	541	24.2	1604	71.6		
8/27/37	279	12.5	1883	84.1		
8/30/37	157	7.0	2040	91.1		
9/ 3/37	137	6.1	2177	97.2		
9/ 6/37	25	1.1	2202	98.3		
9/ 9/37	16	.7	2218	99.0		
9/17/37	18	.8	2236	99.8		
9/23/37	3	.1	2239	99.9		
10/7/37	1	.05	2240	100.0		
	2240					

CHART I

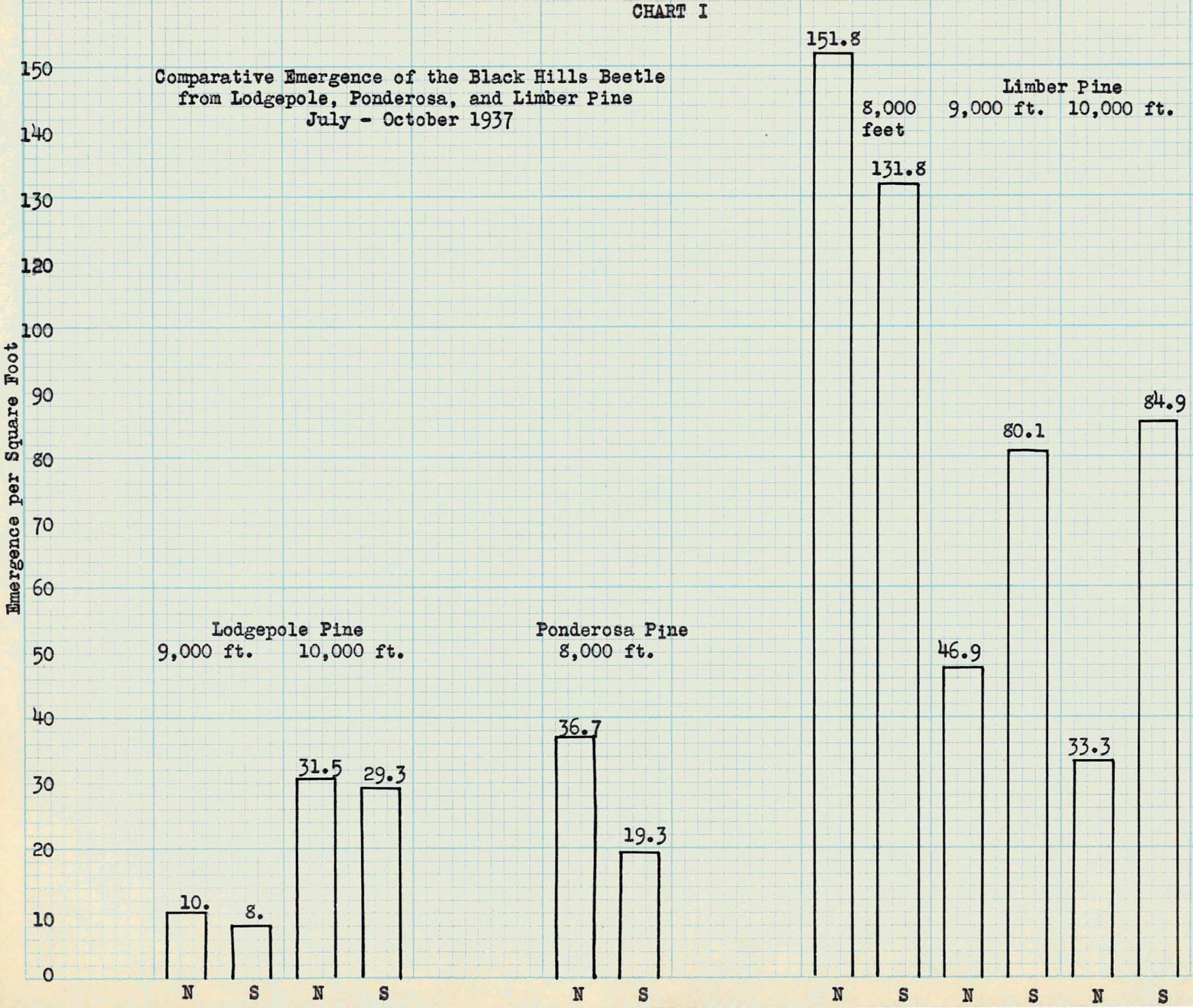
Comparative Emergence of the Black Hills Beetle
from Lodgepole, Ponderosa, and Limber Pine
July - October 1937
Emergence per Square Foot
150
140
130
120
100
90
80
70
60
50
40
30
20
10
0
Lodgepole Pine
9,000 ft.
10,000 ft.
10.
8.
31.5
29.3
Ponderosa Pine
8,000 ft.
36.7
19.3
Limber Pine
8,000 feet
9,000 ft.
10,000 ft.
151.8
131.8
46.9
80.1
33.3
84.9
N
S
N
S
N
S
N
S
N
S
N
S

CHART II

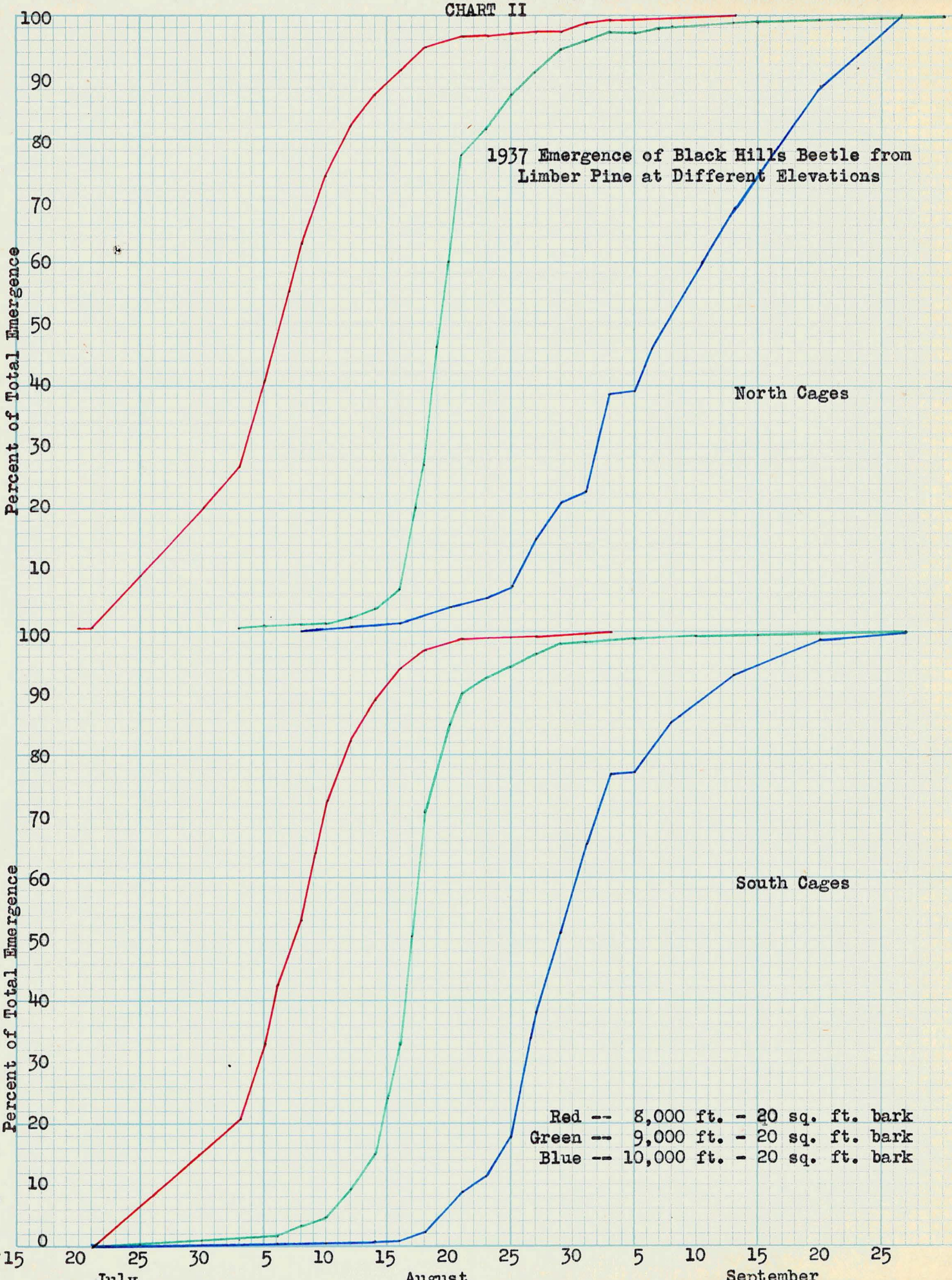
1937 Emergence of Black Hills Beetle from Limber Pine at Different Elevations
North Cages
South Cages
Percent of Total Emergence
Percent of Total Emergence
100
90
80
70
60
50
40
30
20
10
0
15 20 25 30 5 10 15 20 25 30 5 10 15 20 25
July
August
September
Red -- 8,000 ft. - 20 sq. ft. bark
Green -- 9,000 ft. - 20 sq. ft. bark
Blue -- 10,000 ft. - 20 sq. ft. bark

CHART III

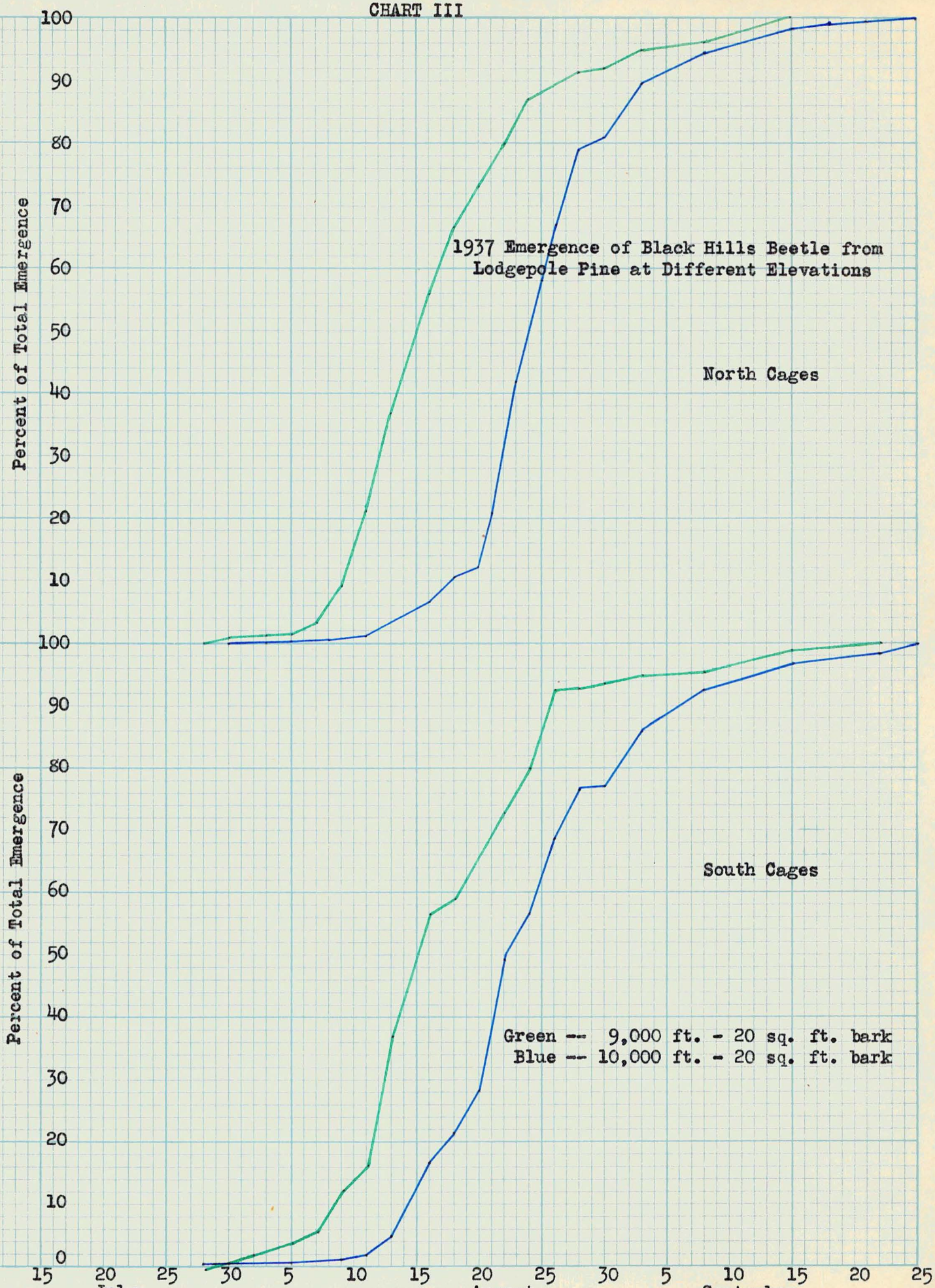
1937 Emergence of Black Hills Beetle from Lodgepole Pine at Different Elevations
North Cages
South Cages
Green -- 9,000 ft. - 20 sq. ft. bark
Blue -- 10,000 ft. - 20 sq. ft. bark
Percent of Total Emergence
Percent of Total Emergence
100
90
80
70
60
50
40
30
20
10
100
90
80
70
60
50
40
30
20
10
0
15 20 25 30 5 10 15 20 25 30 5 10 15 20 25
July
August
September

CHART IV

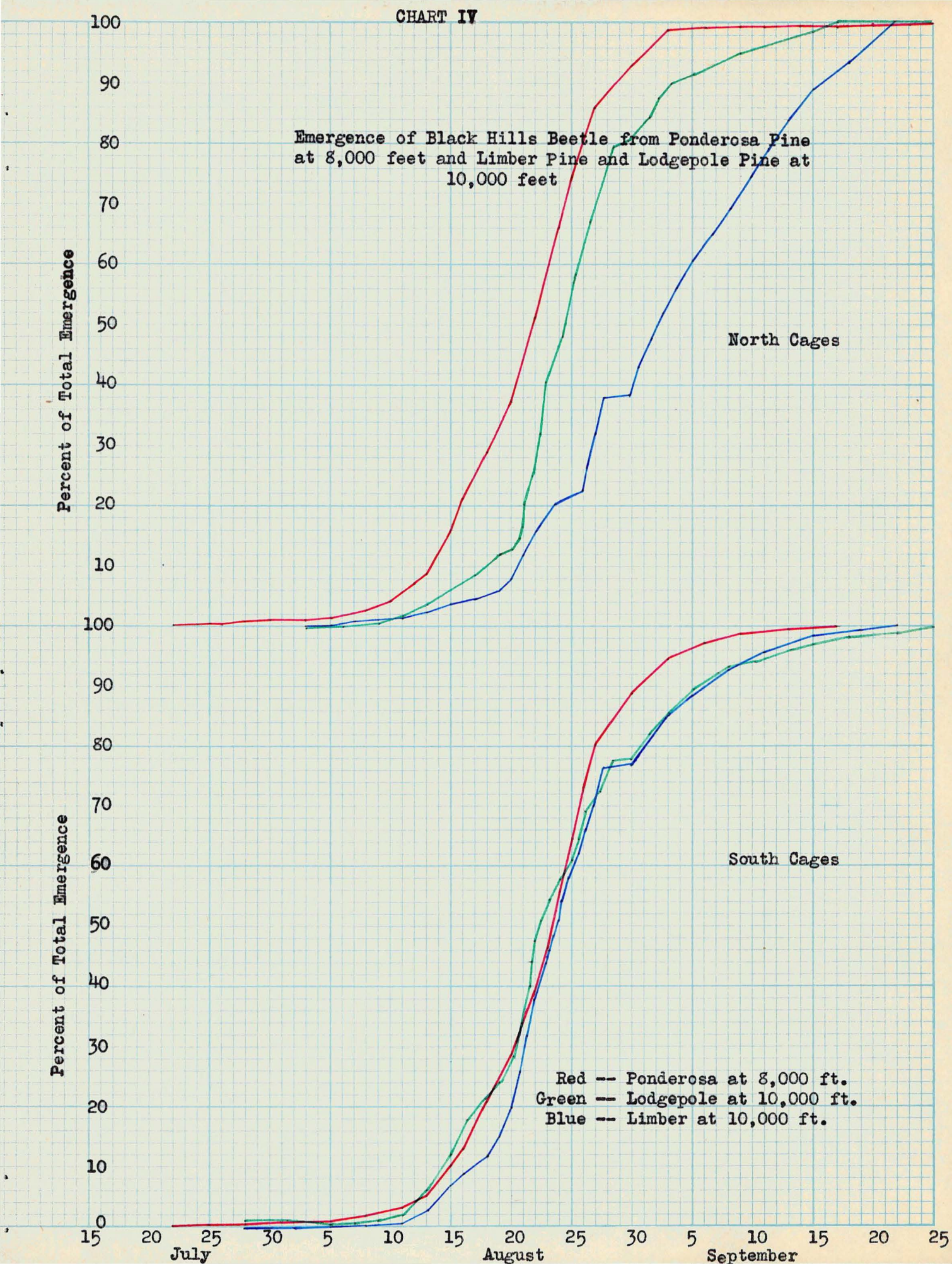
Emergence of Black Hills Beetle from Ponderosa Pine at 8,000 feet and Limber Pine and Lodgepole Pine at 10,000 feet
North Cages
South Cages
Percent of Total Emergence
Percent of Total Emergence
100
90
80
70
60
50
40
30
20
10
0
15
20
25
30
5
10
15
20
25
30
5
10
15
20
25
July
August
September
Red -- Ponderosa at 8,000 ft.
Green -- Lodgepole at 10,000 ft.
Blue -- Limber at 10,000 ft.

CHART V

Black Hills Beetle Emergence per Square Foot from Limber Pine*
at Three Elevations. July to October 1937.

Black -- 8,000 ft. - 80 sq. ft. bark. Ponderosa Pine.
Red -- 8,000 ft. - 20 sq. ft. bark.
Green -- 9,000 ft. - 20 sq. ft. bark.
Blue -- 10,000 ft. - 20 sq. ft. bark.

*Ponderosa pine at 8,000 ft. included.